Climate Change Activities of the Department of Water Resources during 2010

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Field Studies

Twitchell and Sherman Island Subsidence Reversal Projects
Status: In progress
Contact: Bryan Brock

DWR has developed several projects to demonstrate the potential for subsidence reversal and carbon sequestration. Sequestering atmospheric carbon via plant photosynthesis and net retention of carbon within the soil by decomposing plant matter will not only reverse subsidence in the western Delta, but may also help reduce the impacts caused by greenhouse gas (GHG) emissions. Currently, there are three projects that are being studied and include:

- DWR/US Geological Survey (USGS) Wetland Research Facility – Twitchell Island
- Permanent Wetland for Waterfowl - Sherman Island
- Farm Scale Rice Demonstration and Research Facility - Twitchell Island

The Department is working with research institutions and the California Air Resources Board to investigate the potential for a carbon protocol development and eventual sale of carbon credits, which may provide an alternate means of producing income on existing agricultural lands. Through these demonstration projects, DWR will study the costs and benefits of these land use management practices to help define the potential value in a carbon market.

DWR/USGS Wetland Research Facility – Twitchell Island

DWR and the USGS constructed approximately 15 acres of wetlands in 1997 to evaluate land surface elevation changes and carbon accretion due to the accumulation and decay of plant materials. Two ponds were constructed and flooded to depths of 25 and 50 centimeters. Tule and cattail growth was measured as they populated the ponds. Water siphoned from the San Joaquin River keeps the water elevation constant year-round. When plants die at the end of each growing season, they decompose on site and measurements are taken to determine the amount of accumulating organic matter and land surface elevation change.

Ongoing research at this facility has shown that surface elevation changes due to accretion range from 3.2 to 5.6 cm/yr (1.3 - 2.2 in/yr), while surrounding areas used for agricultural purposes lost elevation due to subsidence. The new material bulk density is fairly low (i.e., less than 0.1 g/cm^3), but it has a high degree of structural integrity. The test cores required considerable effort to section with a hacksaw, and there was no evidence of compaction during collection of the cores.

Gas monitoring is also being conducted to investigate carbon sequestration rates, as well as the potential water quality impacts that may occur as a result of the decaying organic matter.

Permanent Wetland for Waterfowl - Sherman Island

The creation of a permanent wetland for waterfowl on Sherman Island—which may also reduce subsidence and sequester carbon was completed on October 1, 2010. The 307-acre parcel on Sherman Island is currently operated as a permanently flooded wetland to encourage and sustain water fowl. The University of California at Berkeley is currently monitoring GHG flux and the Department is working with Moss Landing Laboratories to investigate methylmercury contamination. Data accumulated in this project

will be used to develop a GHG protocol and will help establish flux rates in an emergent wetland system.

Farm-Scale Rice Demonstration and Research Facility

Similar to growing tules, growing rice has shown to be a very effective and sustainable way to reduce subsidence and facilitate carbon sequestration, while maintaining a farm economy. DWR has been conducting research on an approximately 600-acre farm-scale demonstration rice field in the Delta. Key research components of this project include:

- Demonstrating the feasibility of growing rice in the Delta;
- Quantifying subsidence and carbon sequestration rates;
- Determining water quality contaminant loading and exports; and
- Creating best management practices to minimize environmental impacts, while maximizing subsidence reduction and carbon sequestration.

This project has also received funding from the US Department of Agriculture and is projected to continue through 2015.

Planning, Modeling, and Data Collection

Analysis of Climate Change for the California Water Plan Update
Status: **Completed**
Contact: **Rich Juricich**

With input from the Water Plan's Climate Change Technical Advisory Group (CCTAG) and the Statewide Water Analysis Network (SWAN), DWR chose to apply the Water Evaluation and Planning System (WEAP) for Update 2009 as a tool to help quantify future scenarios and alternative water management responses (www.weap21.org). During and after the completion of Update 2005, DWR evaluated several possible approaches to quantify future scenarios for Update 2009, including the Analytica tool used for Update 2005. In 2005, DWR participated in a study with the Stockholm Environment Institute (SEI) funded by the U.S. Environmental Protection Agency to apply the WEAP tool to understand the potential effects of climate change on the Sacramento Valley. DWR chose the WEAP tool for Update 2009 because WEAP:

- has a friendly graphical user interface that supports collaboration,
- requires a shorter learning curve than alternatives,
- was successfully applied by RAND Corp. to evaluate climate scenarios for the Inland Empire Utilities Agency, and
- received generally positive feedback from SWAN and other Water Plan stakeholders.

For Update 2009, most of the scenario analysis was performed at the hydrologic region scale. DWR used WEAP to develop a low-resolution regional water demand representation for each of the 10 hydrologic regions in California. For this analysis, indoor urban demand was represented in a manner similar to that used for the 2005 Update. The representation of outdoor urban and agricultural water demand was improved using evapotranspiration (ET) requirements and irrigation patterns, and variable monthly sequences of precipitation and temperature based on 12 available scenarios representing future climate change.

Future water demand is affected by a number of factors like population growth, planting decisions by farmers, size and type of urban landscapes, future climate, and water conservation measures. Water Plan Update 2009 quantifies several factors that together provide a description of future water demand for the urban, agricultural, and environmental sectors. Each of these factors is varied between three growth scenarios to describe some of the uncertainty faced by water managers. For example, no one can predict future population growth with certainty. The three growth scenarios use three different, but plausible values of future population when determining future urban water demands.

A significant improvement to the Water Plan scenarios in Update 2009 is a quantitative look at the uncertainty surrounding future climate change. Each of the three Water Plan growth scenarios was evaluated in tandem with 12 separate climate scenarios identified by the Governor's Climate Action Team (CAT). At the core of this effort are climate-change scenarios derived from six global climate models:

- From France: CNRM CM3
- From USA: GFDL CM2.1
- From Japan: MIROC3.2 (med)
- From Germany: MPI ECHAM5

- From USA: NCAR CCSM3
- From USA: NCAR PCM1

These models were chosen on the basis of the availability of detailed outputs for use in various parts of the assessment process and upon consideration of certain aspects of their performance. The CAT used each of the six global climate models with two separate GHG emission scenarios developed by the Intergovernmental Panel on Climate Change. The result is 12 separate time sequences of future climate (temperature, precipitation, and relative humidity). Collectively these estimates provide planners with a range of precipitation and temperature that might be experienced in the future and are used in the Water Plan scenarios with other factors to estimate future water demands. As a pilot study, Update 2009 also presents a more detailed analysis of scenarios and water management response packages for the Sacramento River and San Joaquin River hydrologic regions. The pilot study was developed at a suitable (smaller) spatial scale to capture the major hydrologic flows, represent major demographic and land use trends, and evaluate the effects of water management responses. In general, the model is organized by DWR Planning Areas—there are 11 Planning Areas in the Sacramento River Hydrologic Region and 10 in the San Joaquin River Hydrologic Region.

For the four Planning Areas covering the southern Cascade and northern and central Sierra Nevada ranges, the Planning Areas are further disaggregated along watershed boundaries and elevation bands to reflect major reservoir operations and elevation-dependent hydrologic processes. For the remaining 17 Planning Areas, located primarily on the floor of the Central Valley, water demands and water supplies are specified at the Planning Area level, and only disaggregated when necessary to properly reflect usage of different supplies or to evaluate scenarios and response packages of greater interest.

Coordination of Climate Change Analysis Methods for DWR Planning Studies
Status: **Ongoing**
Contact: **Andrew Schwarz**

In 2010, DWR began a two-phase project to coordinate the various climate change analysis methods used in DWR planning studies. The first phase of this project was to survey and describe the procedures and methodologies that have been used in the past by DWR and its partners to characterize future climate and analyze the impact of projected changes. The second phase of this project will be to develop guidance and tools for use by DWR project managers to ensure consistency, quality, and adequacy across all programs and planning studies completed by DWR.

Phase I was completed in December 2010 with the publication of "Climate Change Characterization and Analysis in DWR Planning Studies" by Abdul Khan and Andrew Schwarz. This study is a comprehensive and comparative look at planning studies conducted by DWR and its partner agencies that have addressed climate change. Thirteen past and ongoing planning studies conducted by DWR and its partners between 2006 and 2010 are summarized. Each study was evaluated across 18 different characteristics including number of climate scenarios, climate scenario development approach, hydrologic simulation approach, sea level rise estimation, and project purpose. The thirteen studies were then analyzed together to identify trends over time or across similar type projects. Each of the various climate change characterization approaches and hydrologic simulation approaches are compared and contrasted and strengths and

weaknesses are discussed. The study also discusses the lack of important tools and analysis procedures for measuring some important climate change impacts.
The study provides the background needed to develop guidance for DWR project managers on selecting and implementing climate change analyses. In addition, it also serves as a review of potential approaches available for other water planning entities as they decide how to address climate change in their planning processes.

Phase II of this project will begin in 2011 and be completed in early 2012. Phase II will result in a guidance document and an accompanying climate change data toolbox/web portal to assist DWR project managers with assessing the need for climate change analysis in their planning activities and guiding decision making for selection of analytical tools, assumptions about future conditions, and analysis procedures. The intent of this activity is to improve consistency across DWR documents and streamline decision making and document review while preserving the flexibility of project managers to tailor analysis procedures to their specific project.

Data Collection and Climate Services
Status: Ongoing
Contact: Dr. Michael Anderson

In 2010 DWR continued its collaboration with Western Region Climate Center to augment the visualization of climate data within the California Climate Data Archive. On a related note, the Flood Emergency Response Information Service (FERIS) is under development and will include a tab on climate. Efforts are underway to link information presented in FERIS to the climate data in the California Climate Data Archive. FERIS will also house a new map-based server for (former State Climatologist) Jim Goodridge's precipitation Depth-Duration-Frequency curves and annual extremes data sets. This will greatly facilitate the serving of the data which is currently handled through an ftp site with over 4000 spreadsheets. Data gathering for this effort will be transitioned from Jim Goodridge to DWR in the coming year.

For observing data systems, DWR is continuing its partnership with the Earth Systems Research Lab of the National Oceanic and Atmospheric Administration (NOAA) and Scripps Institution of Oceanography to deploy new monitoring equipment for extreme precipitation events. For this network, water vapor measurements, wind profilers, soil moisture sensors and freezing level radar are being deployed across the state. The data from this network is currently served through NOAA's Hydrometeorology Testbed website. Efforts are underway to get the data into the California Data Exchange Center. Other observing opportunities that are in their initial stages include elements of the Forecast Coordinated Operations Program and the US Historical Regional Climate Reference Network deployment.

Central Valley Flood Protection Plan
Status: Ongoing
Contact: Dr. Michael Anderson

The Central Valley Flood Protection Plan (CVFPP) presents the prioritization and funding expectations for Central Valley Flood System improvements over the next five years. In the legislation mandating the CVFPP, climate change was included as a necessary component. Currently the science of climate change projections is limited in the information it can provide on projected changes to extreme events, particularly

precipitation events that lead to flooding. This is in part due to the fact that many of the controlling processes associated with extreme precipitation events are not represented in the Global Climate Models.

To respond to this challenge, the CVFPP team formed a climate change work group composed of the California State Climatologist and scientists from NOAA, US Geological Survey (USGS), US Bureau of Reclamation (USBR), and US Army Corps of Engineers (USACE). Together, the group formulated a thresholds analysis approach for incorporating climate change into flood system planning. Rather than attempt a traditional impacts analysis that relies on data from the GCMs, the threshold analysis approach works from the capabilities of the flood management system and determines critical thresholds and the associated consequences of crossing those thresholds. Once the thresholds are established a historical analysis can be made to determine the type of extreme event needed to cross the different thresholds. As the processes related to those extreme events are understood, projections of changes to those processes due to climate change can be estimated. From there the changes in the processes need to be modeled in terms of their changes to flood conditions that can be related to the identified thresholds. The method will undergo refinement as it is applied and currently many gaps exist in the evaluation capability for extreme events. This methodology can help clarify the needed research to fill those evaluation capability gaps and help solidify the partnership between research and application.

Analysis of the Impact of Climate Change on Streamflows in California
Status: Ongoing
Contact: Messele Ejeta

For the 2008 biannual report update to Governor Schwarzenegger, researchers generated daily and monthly streamflows for the Climate Action Team (CAT) at 18 locations across California's Sierra Nevada mountain range. The data, which spans the 1950 – 2099 period, was generated for two GHG emission scenarios, each modeled using six different General Circulation Models (GCMs). Results from these models were downscaled to the local level using two methods: 1) the Bias Correction and Spatial Disaggregation (BCSD) method, and 2) the Constructed Analog (CA) method. The BCSD method was applied to the results of all six GCMs for each emission scenario whereas the CA method was applied to the results of three GCMs for each emission scenario. Thus, daily and monthly sets of 12 projected streamflow data corresponding to the BCSD method and six projected streamflow data corresponding to the CA method for all the 18 locations were obtained. The daily and monthly sets of streamflow data have been analyzed with respect to flood occurrence and water supply planning, respectively. A summary report of this analysis is included in the Technical Memorandum report "Analysis, Methodologies, and Evaluations", which was prepared in 2009 and is available upon request.

To meet the main objective of this activity, which is to provide public access to the methodology and data analysis tools used to determine the impact of climate change on streamflows, preliminary work was started using Google Earth. A three-step approach is planned to carry out the objective using this tool: 1) geo-reference the streamflow locations in California where data is available; 2) provide static data (such as meta data, references, and web links to completed impact studies; and 3) provide dynamic tools that the users can utilize to perform customized impact studies. The first step of this activity has

been completed and work has begun on the second step. This activity will require a server to host the data and provide internet access.

This activity is currently being revised not to duplicate efforts; plans include: 1) the continuation of the analysis of the impact of climate change on streamflows as more data becomes available and the climate change modeling processes continue to evolve, and 2) providing public access to the methodology and data analysis tools used to determine the impact of climate change on streamflows.

Coastal and Oceans Climate Action Team – Sea Level Rise
Status: **Completed**
Contact: **Jamie Anderson**

Following the 2008 Executive Order requiring projects in California to consider future sea level rise (SLR) projections, a need was created for guidelines on which sea level projections to consider and how to use that information for planning purposes. The National Academy of Sciences (NAS) has been contracted to review sea level rise projections and to provide planning recommendations by 2012. Planning activities in California needed interim guidelines on how to address sea level rise while awaiting the 2012 NAS report. Therefore the Coastal and Oceans Subgroup Climate Action Team (CO-CAT) assembled a SLR task force to develop the interim guidelines. The SLR task force included representatives from 16 State agencies, including DWR. The Ocean Protection Council's Science Advisory Team provided scientific guidance and answered questions raised by the task force. The SLR task force identified a range of sea level rise projection to be used in planning projects in California. The task force developed a guidance document, and the Ocean Protection Council adopted a resolution to use that guidance document until the sea level rise report from the NAS is available. Plans were also made to update the SLR guidance document as needed.
http://www.opc.ca.gov/2011/04/resolution-of-the-california-ocean-protection-council-on-sea-level-rise/

Using Downscaled Climate Change Information for Water Resources Planning
Status: **Ongoing/Completed**
Contact: **Jianzhong Wang, Francis Chung**

Climate change projections from Global Climate Models (GCMs) typically provide information at a scale that is too large to use for water resource planning. To make the climate change projection information more useful for planning purposes, it is converted to a smaller scale by a process called downscaling. Downscaling methods fall into two categories, statistical downscaling, which is based on historical patterns, and dynamical downscaling, which relies on physical principles and relationships. Both downscaling and the use of downscaled data for water resources planning are evolving areas of research. DWR's activities related to downscaling included:

- Created downscaled data at 2km resolution for California from PRISM-based Bias Corrected Spatial Downscaled (BCSD) data and associated uncertainty estimates
- Comparing dynamical and statistical downscaling methods to better understand the strengths and weaknesses of each method and how that might affect their use for water resources planning purposes
- Generating climate change reservoir inflow projections through a process called double quantile mapping

- Assessing climate change impacts for the Bay Delta Conservation Plan project
- Submitted paper titled "Isolated and integrated effects of sea level rise, seasonal runoff shifts, and annual runoff volume on California's largest water supply" to the *Journal of Hydrology*

Sensitivity Analysis of Sierra Nevada Upper Watersheds to Temperature Changes Using SWAT

Status: **Ongoing**
Contact: **Tariq Kadir**

Physically-based, distributed hydrologic models are essential tools for evaluating long-term hydrologic changes in California. The semi-distributed Soil Water Assessment Tool (SWAT) is being used to develop individual models of six representative Sierra Nevada watersheds: Shasta Lake, Yuba River, Feather River, and the American River in the northern Sierras, and the Tuolumne River and Merced River in the southern Sierras. A common and consistent database of digital elevation, land use, soil and climate data are used with GIS to develop the SWAT models. Model calibration and validation are based on observed or reconstructed monthly unimpaired streamflows at the watershed outlets. The parallel optimization package is used in model calibration. Additional SWAT models will be developed for other major watersheds in the region. The calibrated models will be used to study the effect of imposed warming on the hydrology of these source watersheds and their impacts on water supply of the Central Valley of California.

Climate Change Impacts to State Water Project and Central Valley Project Operations

Status: **Completed/Ongoing**
Contact: **Hongbing Yin, Sushil Arora, Francis Chung**

The State Water Project (SWP) and the Central Valley Project (CVP) are the two major interbasin transfer projects for California's water supply system. Investigating climate change impacts to SWP and CVP operations provides a foundation for developing system adaptation plans. DWR has conducted initial studies of climate change impacts to SWP and CVP operations using the CalSim-II model under existing physical, operational and institutional conditions. Impacts were evaluated for projected changes to streamflows, agricultural water demands, and rising sea levels. Twelve climate change projections recommended by the Governor's Climate Action Team were used for the study. Mid-century and end-of-the-century impacts were assessed for

- Annual Delta exports
- Reservoir carryover storage
- Sacramento Valley groundwater pumping
- Power supply
- Delta X2 salinity standard compliance
- Vulnerability of the system to operational interruption

The initial assessment indicates that SWP and CVP would be impacted significantly by projected climate changes. In order to provide a climate change baseline assessment of SWP and CVP impacts and to help regional scale climate change planning studies, the current assessment needs to be further refined in the following aspects: (1) re-evaluate methods of downscaling GCM model outputs and generating projected streamflows; (2) improve the estimation of projected agricultural water demands; and (3) develop the

hydrologic inputs under climate change conditions for soon-to-be-released CalSim 3.0 model, which will provide linkages to regional scale climate change studies.

DFG Climate Change Stakeholder Groups
Status: Ongoing
Contact: Erin Chappell

The Department of Fish and Game (DFG) has formed three Climate Change Stakeholder Work Groups to identify how to incorporate climate adaptation for ecosystems into various agency programs/projects. DWR participates in these work groups to help ensure consistency in incorporating climate adaptation strategies within the Natural Resources Agency. In 2010, the Outreach Work Group completed work on a magazine to highlight the actions DFG and its partners are taking to address the challenges associated with climate change. The magazine, *Confronting the Challenge: Climate Change and the Department of Fish and Game,* is a tool for communicating the collective vision for adaptation planning that is on going in the DFG and with its partners. The magazine was printed in November 2010 and is available online at http://www.dfg.ca.gov/climatechange/.

The Workshops and Research Needs Work Group planned and held a one-day workshop entitled *Bridging the Gap: Downscaling Climate Models to Inform Management Actions* in November 2010. The workshop provided participants with a shared technical understanding of potential downscaling applications to ecological resource management and provided an opportunity for discussion on data needs and the challenges of dealing with uncertainty, scale and resolution. More information, PowerPoint presentations, and archived web cast can be found at http://www.dfg.ca.gov/climatechange/downscaling-workshop/.

The Framework for Implementing Actions Across the State Work Group continued the development of key elements that will create a structure and process for implementing adaptation actions effectively across the state as well as within regions and local jurisdictions.

Represent DWR on Interagency and Stakeholder Groups
Status: Ongoing
Contact info: Lauma M. Jurkevics

Regional DWR staff participated in a variety of interagency and stakeholder groups, including the following: the DFG Stakeholder Workgroups; the CAT Biodiversity Working Group; the CAT Climate Change, Land Use, and Infrastructure (CCLU-In) Working Group; Delta Stewardship Council; California Landscape Cooperative; CARB AB32 Environmental Justice Advisory Committee; Ventura County Task Force of the Southern California Wetlands Recovery Project; and the Bay Area Ecosystem Climate Change Consortium. In June regional and headquarters staff discussed with other agencies strategies for managing water and developing decision-support tools for local communities in a three-day bi-coastal (San Francisco and New York) meeting organized by EPA ("EPA Regional Science Workshop: Resilient Water Management Strategies for a Changing Climate"). Other collaboration occurred with the Local Government Commission and Geos Institute, which hosted a June workshop and October roundtable discussion attended by staff. This effort was initiated to develop an integrated adaptation strategy for Fresno County and culminated in a series of reports accessible at

http://www.lgc.org/adaptation/fresno/. In addition, staff has been assisting the City of Fresno with updating its General Plan to include adaptation and sustainability practices and the Fossil Discovery Center of Madera County in developing an exhibit on climate change.

National Research Council (NRC) Sea Level Rise Study
Status: Ongoing
Contact: Jeanine Jones, John Andrew

In 2010, the contracting process was completed to put in place funding for the National Research Council (NRC) sea level rise (SLR) study called for in Executive Order S-13-08. DWR executed contracts with four other California state agencies and with Oregon and Washington for their contributions to the West Coast SLR study; three federal agencies provided their share of the funding directly to NRC. Study funding is summarized in the table below; DWR's contribution to the study is in the form of in-kind services to manage the work. DWR's master contact with NRC on behalf of this consortium of agencies was also executed this year, allowing NRC to begin its process of selecting members of the study. The bulk of the committee's work will occur in 2011, with completion of the study expected in early 2012. The report will include estimation of a range of likely amounts of SLR in 2030, 2050, and 2100.

Contributor	California ($)	Other States ($)	Federal ($)
State Water Resources Control Board	95,000		
California Energy Commission	95,000		
Ocean Protection Council	100,000		
Caltrans	95,000		
Washington Department of Ecology		70,000	
Oregon Water Enhancement Board		49,999.99	
US Geological Survey			25,000
National Oceanic and Atmospheric Administration			25,000
US Army Corps of Engineers			25,000
Totals	385,000	119,999.99	75,000
		Grand Total:	$579,999.99

Paleohydrology
Status: Ongoing
Contact: Jeanine Jones

The Department executed a contract with the University of Arizona for development of tree-ring reconstructions of paleostreamflows in the Sacramento, San Joaquin, and Klamath River Basins. Extending streamflow records beyond the relatively short period of the historical record provides an improved picture of climate variability and yields data for use in operations model sensitivity analyses and for vulnerability analyses. Very limited fieldwork under the contract began in fall 2010; most of the field work will occur in 2011, and will wrap up in 2012. The final report will be completed in 2013.

Operations

Coordinated Reservoir Operations
Status: Ongoing
Contact: Boone Lek

DWR has developed and implemented the Forecast-Coordinated Operations (F-CO) program for the Yuba-Feather basins and is currently working on expanding the program to the San Joaquin drainage basin and eventually to other major reservoirs in the Central Valley. The goal of the F-CO is to improve downstream flood protection without impacting the water supply of the upstream reservoirs. A program objective is to reduce downstream peak flows though improved forecasting and enhanced communication and coordination. The F-CO program will allow operators to make controlled releases ahead of flood events allowing for more water supply storage during the flood season (October through April). Increasing operational flexibility and flood control space is critical if the expected climate change impacts of higher snowlines, decreased snowpack, and earlier snowmelt are realized. This may include updates to applicable water control manuals (or at least flood control curves) issued by the US Army Corps of Engineers.

The F-CO program is considered one of the most cost-effective measures to improve flood control and is currently being implemented on the Yuba-Feather system. The F-CO will help minimize the risk of exceeding river channel capacity and increase the warning times to communities along the major California rivers and downstream of flood control reservoirs through enhanced communication between local, state and federal agencies; improved data gathering and exchange; and utilization of the most recent advancements in weather and river forecasting. Since 2008 an annual exercise has been held in early Fall to test the reservoir operators and managers in reacting to various flood scenarios.Project developments in Water Year 2010-11 included:Expanded the F-CO to the San Joaquin River basin and started working with operators of New Exchequer, Friant and Pine Flat reservoirs; andDeveloped a prototype application that was utilized to coordinate operations of San Joaquin reservoirs during the spring snowmelt runoff season.

Evaluation of Benefits of Reoperation of Water Supply and Flood Protection Systems
Status: Development
Contact: Sean Sou

California's water system is composed of state, federal, and local agencies, each having infrastructure in place to provide water supply and flood control benefits. The current operation of these independent systems is based on physical and legal constraints. Changes in the climate, legal framework, and social values associated with water use may require modifications to existing operations and management procedures, new facilities, and new laws.

Senate Bill X2 1(SB X2 1) authorized DWR to perform a system reoperation study to identify potential reoperation strategies of California's existing water supply and flood protection systems that will optimize the use of existing facilities and groundwater storage capacity. System reoperation refers to changes made to existing operations and management procedures to achieve a certain objective(s). The following are objectives of the System Reoperation Program as defined by SB X2 1:

a) Integrate flood protection and water supply systems to increase water supply reliability and flood protection, improve water quality, and provide for ecosystem protection and restoration.

b) Re-operate existing reservoirs, flood facilities, and other water facilities in conjunction with groundwater storage to improve water supply reliability, flood control, and ecosystem protection, and to reduce groundwater overdraft.

c) Promote more effective groundwater management and protection and greater integration of groundwater and surface water resource uses.

d) Improve existing water conveyance systems to increase water supply reliability, improve water quality, expand flood protection, and protect and restore ecosystems.

DWR is developing a Plan of Study which will identify and describe the four phases of the system reoperation study: Plan of Study (Phase 1), Scenario Reformulation (Phase 2), Reconnaissance-level Assessment (Phase 3) and Feasibility-level Assessment (Phase 4). Appropriate climate change scenarios will be incorporated in the system reoperation study. More information on the System Reoperation Program can be found at http://www.water.ca.gov/system_reop/.

DWR will prepare a programmatic feasibility report that will describe the formulation of potential reoperation strategies, the engineering feasibility assessment and cost estimation, and identify institutional and legal constraints and challenges to implementing the strategies. The studies and the programmatic feasibility report are anticipated to be completed at the end of 2013.

Evaluation of Benefits of Meadow Restoration on Sierra Nevada Water Supply

Status: **In progress**
Contact: **Harry Spanglet**

In a natural, un-degraded condition, mountain meadow communities have deep soils, dense vegetation, and a naturally-developed drainage pattern where water flows across the flat meadow surface and infiltrates the soil; shallow meandering channels then carry water to downstream drainages. Meadows typically remain fully saturated for most of each year and can store substantial quantities of groundwater in their soils, acting as natural reservoirs of water at high elevations. Slow release of water stored in meadow sediments can provide base flow to downstream drainages long after surface runoff has stopped for the season; in addition, the water storage capacity of meadows can buffer the rate of water runoff during snowmelt and reduce peak flows that cause flooding downstream. The net result is a reduction in extremes of runoff, increasing the low flow and reducing peak flows.

Degraded meadows that have been exposed to poor land-use practices, such as overgrazing of livestock, off-highway vehicle traffic, and draining, typically exhibit "gully erosion," in which shallow channels are deeply eroded and all water entering the meadow drains rapidly into stream channels rather than across meadow surfaces. The channelized flow does not allow the soils to become saturated, eliminating the beneficial hydrologic effects of meadow communities and leading to drastic changes in meadow vegetation. Meadow restoration is the practice of reversing the effects of gully erosion by filling gullies and re-establishing a quasi-natural hydrologic regime by redirecting surface flows across meadows, allowing water to infiltrate the sediment, raise groundwater levels, and potentially restore the beneficial hydrologic functions of meadows.

DWR is funding the US Forest Service for a three-year investigation of the hydrologic effects of meadow restoration and how restored meadows can contribute to

improved system operation as well as ecosystem functioning. In 2010 the project began meeting the goals of the funding, including: delineating potential meadows using available Geographic Information System (GIS) datasets, delineating meadows in the field and comparing the field delineations to those derived from GIS analysis; assessing meadow condition in a random sample to extrapolate to the condition of all Sierra meadows; installing instrumentation to assess hydrology of undisturbed and restored meadows.

Energy and Greenhouse Gas Emissions

Water-Energy Subgroup of the Governor's Climate Action Team ("WETCAT")
Status: Ongoing
Contact: Dale Hoffman-Floerke/Jim Lin/John Andrew

DWR co-chairs the Water-Energy Subgroup—better known as the "WETCAT"—of the Governor's Climate Action Team. The WETCAT coordinates and focuses its efforts on GHG emission reduction actions related to the transport, treatment, delivery and use of water for agricultural, residential, and commercial needs. In addition to DWR, the principal agencies in the subgroup are State Water Resources Control Board, California Energy Commission, and the California Public Utilities Commission (CPUC). In 2008, the WETCAT developed and proposed five measures to the California Air Resources Board for inclusion in the AB 32 Scoping Plan.

- Water conservation
- Water recycling
- Energy intensity of water systems
- Urban runoff and stormwater reuse
- Renewable energy production

In 2010, the WETCAT continued implementation of these five measures. In particular, DWR leads the implementation of the "20x2020" program to reduce per capita water use by 20% by 2020. The Subgroup also reviewed: 1) a report from UC Berkeley's Goldman School of Public Policy on the implementation of a public goods charge for water (also a measure in the AB 32 Scoping Plan); and 2) the progress of water-energy pilot projects ordered by the CPUC.

CAT Subgroups

In addition to the WETCAT, DWR actively participates in all of the Climate Action Team Subgroups or Working Groups that focus on specific sectors.

Working Group	DWR Representative
Agriculture	Megan Fidell
Biodiversity	Erin Chappell
Energy	Veronica Hicks
Forestry	Harry Spanglet
Land Use/ Infrastructure	Michelle Selmon
Coastal and Oceans	John Andrew
Public Health	John Andrew
Research	Jeanine Jones
State Government	John Engstrom

Integrated Resource Plan for the State Water Project
Status: Development
Contact: Veronica Hicks

To plan for the long-term energy needs of State Water Project (SWP) to support water delivery requirements, DWR developed an Integrated Resource Plan (IRP). The IRP considered operational, economic, and policy needs of the SWP, and reflects a balanced approach to meeting these needs. One component of the plan is a procurement strategy that replaces expiring contracts such as the Reid Gardner coal plant with newer and cleaner natural gas power resources (e.g. Lodi Energy Center), and zero emission resources, including certifiable renewable. The IRP outlines a plan that will keep SWP operations consistent with the GHG reduction goals established by the Governor's Executive Order S-03-05 and AB 32.

In developing the IRP, DWR had to consider numerous operational and regulatory constraints and objectives the SWP is committed to meeting:

- Reliable water deliveries;
- Affordable water deliveries;
- Protection of the natural environment;
- Responsibilities under regulatory authorities; and
- State and federal environmental policy goals.

As an example of the challenges DWR faces in balancing the needs and requirements of the SWP IRP, in December 2007, US District Court Judge Oliver Wanger imposed restrictions on water deliveries from the Delta to protect the threatened delta smelt. The order has significantly decreased water deliveries to homes, farms, cities and industry by both the SWP and the federal Central Valley Project, and has fundamentally affected SWP operations. The full impact of the reduction of the SWP's available energy resources, pumploads, and therefore GHG emissions, will in turn affect the SWP's IRP.

To date, DWR's strategies for reducing emissions include

- To develop and maintain a transparent and accurate record of the SWP's energy profiles and baselines,
- The SWP's current energy efficiency improvements programs include the refurbishment and replacement of DWR's hydroelectric generators and pumps at key SWP plant facilities.
- Since July 1983, DWR has received energy from Reid Gardner (RG) Powerplant, a coal-fired facility near Las Vegas, Nevada. This long-term agreement for energy from RG Unit No. 4 expires in July 2013, at which point, the SWP's CO_2 emissions levels will be nearly half of what they were in 1990. To replace this energy with cleaner, more efficient resources, DWR is investigating cleaner technologies such as natural gas combustion turbines, wind energy, small hydroelectric generation, as well as additional energy efficiency projects, and contracts for renewable energy resources.
- During high energy demand periods over the summer months of 2007 and 2008, the SWP was the largest provider for California's Demand Response Program (DRP). Curtailment of loads under the DRP results in avoidance of dispatch of the least efficient thermal generators.

2009 Emissions Reports to the California Climate Action Registry and the California Air Resources Board

Status: **Ongoing**
Contact: **Holly Cronin/Veronica Hicks**

DWR reported its estimated total direct and indirect CO_2 emissions to the California Climate Action Registry (CCAR) for the third consecutive year. The emissions are the result of the State Water Project (SWP) power purchase transactions, energy consumed at DWR-occupied buildings, and fuel consumed by DWR's vehicles and field equipment. The Department's CCAR Greenhouse Gas Emission Report was audited and approved by an independent third party certifier in October 2010. Ninety-nine percent of DWR's emissions in 2009 were the result of SWP power purchases. In May 2010, DWR reported the energy generated and consumed by the SWP in 2009, and also the estimated sulfur hexafluoride associated with the SWP's transmission yard circuit breakers, to the California Air Resources Board (ARB).

Business Practices and Technical Expertise

Cement
Status: **Completed**
Contact: **Gordon Enas**

Emissions of GHG from cement production arise primarily from chemical processing (calcination) and fossil fuel combustion. While the cement industry has achieved significant GHG emission reductions since 1990, opportunities for further reductions still exist, particularly with expanded research into cement processing and concrete blending technologies. DWR was tasked to identify its current contribution to cement-related GHG emissions and then develop a policy to use cement with a lower carbon content, if technically feasible, in DWR construction, maintenance, and replacement activities.

The Division of Engineering (DOE) examined its current practice for specifying cement for reinforced concrete and controlled low-strength materials (CLSM). DOE typically specifies Portland cement conforming to ASTM C 150 requirements, which allow up to 5% limestone rock dust to be included with the final Portland cement product. This is consistent with the recommendation made by the Cement Subgroup of the Climate Action Team to substitute other cementitious materials such as pozzolan (flyash), blast furnace slag, silica fume and limestone for cement, thereby reducing GHG emissions associated with cement production.

Addressing Climate Change in Departmental CEQA Documents
Status: **Completed/On going**
Contact: **Katy Spanos/Heidi Rooks/Andrew Schwarz/John Andrew**

In June 2009, the Director formally established the CEQA Climate Change Committee ("C4") to review all climate change analyses in DWR environmental documents and exemption considerations prior to publication. Since 2008, C4 has reviewed and commented on over a dozen environmental impact reports and nearly 60 other Departmental environmental documents. Through these reviews the committee has developed environmental analysis methodologies and reference materials for use by Department staff and consultants. These methodologies and materials are used to help DWR comply with environmental documentation required to implement laws, regulations, and other operational mandates pertaining to climate change and GHG emissions. These guidance documents also provide a consistent approach to conducting project specific environmental analyses for CEQA compliance documents, biological assessments, permit applications, and other environmental needs. Because of the evolutionary nature of climate change analysis, these documents will be updated periodically to include the most current legal rulings and expert thinking on the subject.

During 2010, the CEQA Climate Change Committee initiated discussions and formed a work group and steering committee to develop a comprehensive approach to addressing climate change. The efforts of this work group have resulted in the development of a three-phase Departmental Climate Action Plan. Each phase of this Climate Action Plan will address a specific area of concern with respect to climate change and the Department's activities. Phase I will be a Greenhouse Gas Reduction Plan documenting historical, current, and projected futures emissions of GHGs from DWR activities as well as strategies and targets for reducing future emissions. Phase II will be a Climate Change Analysis Framework to provide DWR project managers with guidance and tools for characterizing

future climate conditions and analyzing the impact of climate changes for DWR planning studies such as environmental impact reports, the California Water Plan, and the State Water Project Delivery Reliability Report. Phase III will be a detailed incorporation of adaption in environmental documents, building on "*Managing an Uncertain Future; Climate Change Adaptation Strategies for California's Water*" which was published by DWR in October 2008.

During 2010, work began on development of Phase I of the Climate Action Plan-Greenhouse Gas Reduction Plan. Meetings and consultations were conducted with all of the divisions of the department that have operational control over activities that release GHGs. Work on the Greenhouse Gas Reduction Plan will continue in 2011 and is expected to be completed by mid to late 2011.

Sustainability
Status: In Progress
Contact: Mary Simmerer

DWR has established a Sustainability Policy, which received approval from former DWR Director Snow, on April, 22, 2009. DWR's Sustainability Policy embodies the goals and directions the Department will take to be a sustainability leader within State government and the California water community. The policy sets initial targets in the following areas:

- Carbon- 50% reduction below 1990 levels by 2020 (consistent with the AB 32 Scoping Plan); 80% reduction below 1990 levels by 2050 (EO S-0-05)
- Energy- Progressive acquisition of 360 GWh of renewable energy resources by 2020; reduce grid-based retail energy demand 20% by 2015; ensure Energy Star purchasing (EO S-2-04)
- Wastewater- Incorporate recycled wastewater and/or greywater into facilities if technically feasible and cost-effective
- Waste- 50% diversion form waste stream by 2020 (AB 1016)
- Water- 20% reduction in per employee water use by 2020 (consistent with SB 7x-7)

DWR established a sustainability workgroup to help guide DWR's efforts in seven basic areas: climate protection practices, ecosystem stewardship, sustainable business operations, greening facilities, greening fleets, recycling and waste management, and environmentally preferable procurement. The sustainability workgroup presented an implementation plan to DWR's Governance Board on April 19, 2010 that proposed expanding staff resources for sustainability efforts as well as adopting initial sustainability targets in key business areas. The plan further recommended three sustainability pilot projects based on identified targets. Finally, the plan also suggested developing aspects of sustainability as a foundation in DWR's policies over the next three years. Sustainability aspects chosen were: environmental stewardship, business resources management and climate resilience. Moreover, activity specific sustainability guidelines for implementing the sustainability policy would be developed annually. The working group meets monthly.

During 2010, Department sustainability accomplishments included:

- Mary Simmerer was hired as DWR's first Sustainability Coordiantor.
- Environmental stewardship was formally adopted as a sustainability aspect in October 2010 and environmental stewardship practices are being incorporated into DWR's engineering practices.

- Continuing development of sustainable business practices both in the accomplishment of DWR's mission and in its daily operations. As part of the greening of facilities, DWR has created the Sustainable Facilities Operations (detailed below).

Sustainable Facilities Operations - Greenhouse Gas (GHG) Initiatives
Status: In progress
Contact: John Engstrom

DWR will identify, measure, and implement sustainable facilities operations practices to reduce GHG, and educate employees in these practices. The sustainable facilities operations practices to make DWR "greener" will include reducing energy and resource consumption, while lowering greenhouse gas emissions and creating healthier working environments for DWR employees. The development of these enhanced business practices will include:

- DWR will integrate a document management system into its daily business operations. This type of system will reduce paper quantity and create an electronic system for tracking of approvals and electronic retention of documents to save time and resources;
- DWR will continue to promote the Environmentally Preferable Purchasing (EPP) program to utilize procurement methods that provide options for purchasing green" products;
- DWR will increase its efforts to reduce, reuse, recycle, and rethink in all areas of DWR's daily business activities. DWR will look at continuing to increase its waste reporting metrics under SB 1016 by using annual waste disposal as a factor when evaluating program implementation.
- DWR will promote and implement energy and water efficiency and conservation in all capital and renovation projects as well as operations and maintenance activities within budgetary constraints and programmatic requirements;
- DWR will promote ways to reduce employee business travel for meetings by use of technology like teleconference centers or web casting. In addition, training webinars and other online training opportunities will be investigated to reduce training commute for employees.

Other actions in progress or in planning to promote a more sustainable business include:

- DWR will continue to educate through outreach activities like the annual Green Week event, quarterly Green Print articles, Pod Cast, *DWR News/People* articles, and Aqua Net announcements.
- DWR will provide an official office supply reuse center ("Green Pastures") on the 3rd floor of the Resources Building for new, gently used, or open box office materials that will be available to all DWR employees free of charge.
- DWR will purchase additional bicycle lockers to promote alternative transportation (bicycling) and the many benefits such as improved health, less stress, reductions in air pollution, traffic congestion and energy consumption.
- DWR will continue to work on a proposed Payroll Deduction Transit Pass Program. This proposed program came from a suggestion made to the Green Team. The proposal recommends that monthly transit passes be sold through a pre-tax payroll deduction program, which benefits both employees and the Department.

- DWR has implemented a pilot Tire Pressure Monitoring Program. When completed, the pilot project will help DWR determine the need for an in-house program to maintain proper tire pressure in order to promote employee safety, curb fuel consumption, minimize carbon emissions, and reduce costs.

In 2010, accomplishments included:

- Environmentally Preferable Purchasing (EPP) Practices - the Purchasing Services Office held purchasing workshops to update the department buyers about the EPP program and why it is in the best interest for the Department to utilize this opportunity. The purchases are reportable in many cases under the mandated goals outlined in the Public Contract Code (PCC) (12153-12320) for buying recycled-content products (RCPs). The goal of this effort is to increase purchases of RCP's.
- Green Week - Green Week is celebrated in April during Earth Week. The week highlights information on the 4R's (Reduce, Reuse, Recycle and Re-Buy), Environmentally Preferred Purchasing (EPP), Earth Day, Arbor Day, and DWR's role in promoting like principles with respect to DWR's mission.
- Green Print and Podcasts- DWR has promoted sustainability through quarterly "Green Print" articles posted on AquaNet. The articles discuss sustainable opportunities that staff can utilize both at work and at home. In addition, a podcast was produced on efforts DWR is taking to green business operations.
- Green Award for Reduction of Waste Disposal- A DWR sustainability award was created to promote waste reduction and recycling within our Department. The recipient of this Diversion Award disposed the least amount of waste from 18 primary categories and six hazardous waste material categories. The first award was presented in 2008.
- Leadership in Energy and Environmental Design (LEED) Buildings- The State Water Project Southern Field Headquarters is currently under construction as DWR's first LEED Gold building.

Stewardship Policy
Status: **Ongoing**
Contact: **Erin Chappell/Andrew Schwarz**

In October 2010 DWR's Director Mark Cowin approved the Environmental Stewardship Policy. This policy was developed to advance a Department-wide "Total Resource Management" approach to planning activities and projects. As stated in the Environmental Stewardship Policy, DWR managers can incorporate environmental stewardship into their water supply and flood protection programs and projects in several ways: integrate ecosystem protection and restoration into water storage and conveyance and flood control/management planning; include environmental stewardship and ecosystem protection and restoration as criteria in project funding decisions for all DWR programs; plan for conservation, restoration and maintenance of the biological diversity and natural physical processes of aquatic and related terrestrial ecosystems; and plan and implement projects that contribute to the recovery of aquatic and riparian species listed under the federal and state Endangered Species Acts and other laws, as well as other at-risk species.

In an effort to further integrate and implement the concepts of environmental stewardship and sustainability, the Water Resources Engineering Memorandum (WREM)

58a Update Workgroup was established in November 2010. The WREM series is a means of permanently recording and disseminating engineering management decisions to the staff. WREM 58a: Coordination of Environmental Requirements (dated October 7, 1997) outlines DWR policy and guidelines on complying with environmental laws and how to facilitate and promote intradepartmental communication and coordination to implement water resource development projects. Once completed, WREM 58b will build on the guidelines provided in WREM 58a to provide implementation guidelines for the Environmental Stewardship Policy. WREM 58b will provide guidelines for consideration and application of Environmental Stewardship Principles along with project-level guidelines to improve DWR's ability to meet or exceed environmental compliance requirements.

Climate Change Matrix Team
Status: **Ongoing**
Contact: **John Andrew**

DWR's Climate Change Matrix Team includes representatives from every division and major program in the Department. The team of approximately 40 staff (membership is on the last page of this report) meets quarterly to communicate and coordinate on climate change issues. Meetings regularly feature an external speaker on climate change, Department and State policy discussion, and an update from the State Climatologist.

DWR Climate Change Program
Status: **Ongoing**
Contact: **Elissa Lynn/John Andrew/Michael Healey**

DWR significantly expanded the Climate Change program in 2010 with funding from Proposition 84. Full-time staff grew to eight persons, including a new Program Manager II, Bay-Delta Authority, and four Staff Environmental Scientists, one in each regional office.

Grantmaking and Technical Assistance

Integrated Regional Water Management Grant Program
Status: **Implementation**
Contact: **Tracie Billington**

In August 2010 DWR issued the IRWM grant program guidelines and proposal solicitation packages for implementation and planning grants. The guidelines include the IRWM plan standard for climate change; the standard addresses both adaptation to the effects of climate change and consideration of GHG emissions when selecting project alternatives. Climate change is also discussed as part of the Description of Region and Project Evaluation plan standards. Adaptation to climate change and reduction of GHG emissions are also program preferences. Thus, proposals meeting these preferences will earn additional points in the application scoring process. In 2010, DWR started grant solicitation efforts for planning and implementation grant proposals, receiving 39 applications. Grant awards are scheduled for 2011.

Integrated Regional Water Management Grantees CEQA Documents
Status: **Ongoing**
Contact: **Lauma M. Jurkevics**

In preparing for proposed amended guidelines to CEQA, DWR staff finalized in January 2010, through the DWR CEQA Climate Change Committee, an internal guidance for addressing climate change and GHG emissions in CEQA documents developed by DWR and its contractors. This guidance consisted of five documents, which included the *Guidance for Quantifying Greenhouse Gas Emissions and Determining the Significance of their Contribution to Global Climate Change for CEQA Purposes*. The amendments to the CEQA Guidelines were later adopted in March by the Natural Resources Agency. As a result, the DWR internal guidance for discussing and quantifying emissions was added to the *IRWM Climate Change Document Clearinghouse*, a library of resources staff developed and provided to current and potential IRWM grantees. In coordination with the Financial Assistance Branch and the Office of Chief Counsel, further informal CEQA guidance and frequently asked questions (FAQs) as they relate to GHG analysis were drafted for grantees in 2010. Additional assistance on CEQA was provided through the 2010 grant workshops organized by the Financial Assistance Branch.

Climate Change Handbook for Regional Water Planning
Status: **Ongoing**
Contact: **Andrew Schwarz**

In February 2010, DWR executed an interagency agreement with US EPA Region 9 to complete a handbook for incorporating consideration of climate change into regional water planning and management. In addition to US EPA, the US Army Corps of Engineers, and the Resources Legacy Fund are also partner agencies.

The Climate Change Handbook for Regional Water Planning will be a comprehensive guide to the key steps in the regional water planning process, including vulnerability assessment, measuring impacts, developing and analyzing strategies, and planning under uncertainty, decisions and considerations at each step in the process, and technical resources, tools, and methodologies. The handbook, though generally applicable

to a wide range of regional water planning frameworks, will use the Integrated Regional Water Management (IRWM) process as the model planning process throughout the handbook. The handbook will be an important resource for IRWM planning groups for meeting the Proposition 84 and IE IRWM Grant Guidelines, which for the first time include a requirement to address GHG emissions and the effects of climate change. The handbook will not, though, supplant the guidelines. It will provide detailed guidance on potential approaches to incorporating climate change considerations into the planning process. In June 2010, a workshop was held with the Roundtable of Regions, a group of IRWM planning entities that meets regularly to discuss IRWM issues, to present a draft framework and table of contents. The project team received feedback from members of the Roundtable of Regions that was incorporated into further development of the handbook. Several additional feedback sessions are planned for 2011, when a complete draft of the document will be available for review. Completion of the final handbook is anticipated in the last half of 2011, prior to the second proposal solicitation for Proposition 84 and IE IRWM planning grants funding.

Provide Assistance for Integrated Regional Water Management (IRWM) Plans
Status: **Ongoing**
Contact: **Lauma M. Jurkevics**

DWR staff, located in the four regional offices, provided technical assistance and outreach to IRWM planning groups, water agencies, and local governments to incorporate climate change mitigation and adaptation into their planning efforts. Assistance included interacting with local entities at the *California Financing Coordinating Committee 2010 Funding Fairs* during February through May, distributing information at the *IRWM Grant Program Public Comment Meetings* held in April, attending local IRWM stakeholder meetings, providing materials and discussing grant applications at the IRWM planning workshops in August and September and the IRWM implementation workshops in November, and developing flowcharts and FAQs for grant applicants. Staff also attended an IRWM Roundtable of Regions meeting in July where headquarters staff presented a draft framework for the *Climate Change Handbook for Regional Water Planning* to elicit feedback from the regions.

Staff from headquarters and the regional offices reorganized and updated DWR's climate change website (http://www.water.ca.gov/climatechange/) with new resources and publications, summarized key documents (*IRWM Climate Change Document Clearinghouse*) and vulnerabilities (*Climate Change Vulnerability Matrix)* for use by local groups, and worked with climatologists to consolidate historical precipitation data. In addition, staff assisted with developing a workshop focused on downscaling climate models (November 3, 2010, Workshop on "Bridging the Gap: Downscaling Climate Models to Inform Management Actions" presented by California Department of Fish and Game, US Geological Survey, and US Fish and Wildlife Service) and summarized and evaluated climate change analysis in planning studies conducted by DWR and its partner agencies (*Climate Change Characterization and Analysis in California Water Resources Planning Studies,* December, 2010).

Provide Assistance for DWR CEQA Documents
Status: Development
Contact info: Andrew Schwarz/John Andrew

DWR staff, located in the four regional offices, also provides technical assistance to project managers to incorporate climate change into their CEQA documents for DWR projects. This work will include indentifying needed work and providing advice regarding sources of data and analysis.

Federal Grant Programs
Status: Ongoing
Contact Info: Jeanine Jones

The University of Arizona's report--funded by a NOAA's Sectoral Applications Research Program (SARP) grant--on drought scenarios used for the water shortage contingency plan element of Urban Water Management Plans (UWMPs) was completed this year. A set of new SARP grant applications was prepared in coordination with research institution co-sponsors and submitted to NOAA for the 2011 funding cycle. The Department also continued to work with NASA on implementation of its American Reinvestment and Recovery Act grant for remote sensing applications related to water management. The application with the most immediate relevance for climate change adaptation is for remote sensing of snowpack, to improve the coverage provided by existing ground-based snow sensors.

Provide Assistance for Water Use Efficiency
Status: Development
Contact info: Manucher Alemi

The Water Use and Efficiency (WU&E) Branch responds to inquiries about how to use water efficiently at all levels, from statewide usage to options specific to the State Water Project. DWR also requires grant applicants to analyze the energy impacts of their water conservation projects, and requires grant recipients to calculate and report the water and energy savings achieved through the grant-funded projects. WU&E will work with other organizations within DWR and with federal and other State agencies (e.g. US Environmental Protection Agency, US Bureau of Reclamation, California Energy Commission, Air Resources Board, California Public Utilities Commission), to gather and disseminate information about methods to use water efficiently and to reduce GHG emissions. Staff will conduct research and analysis to determine the most cost-effective programs, projects, or practices that can be implemented to meet the GHG emissions reductions mandated by Assembly Bill 32 (AB 32).

National and International Scientific and External Coordination Committees
Status: Ongoing
Contact: Jeanine Jones/Maury Roos

During 2010, DWR staff again engaged with national and international climate change efforts. Jeanine Jones served on NOAA's Climate Working Group, a subcommittee of NOAA's Science Advisory Board, and on USEPA's State and Tribal Council, a newly created federal climate change advisory committee. She also

represented the Western States Water Council (WSWC) on a technical advisory committee to the federal Climate Change and Western Water Group (a coalition of USBR, USACE, NOAA, and USGS). She served on the Western Governors' Association Climate Adaptation Workgroup, and chaired the WSWC Climate Change Subcommittee. She created a new federal agency/California climate change adaptation workgroup, modeled after WSWC's WestFAST federal agency support group. The new workgroup met once in person and is continuing to meet via conference call. In addition, Maury Roos consulted on Technical Paper VI, *Climate Change and Water*, of the Intergovernmental Panel on Climate Change. John Andrew was also invited to present at the kickoff of the National Climate Assessment, and was consulted later on its development.

Public Outreach

Status: **Ongoing**
Contact: **Elissa Lynn**

DWR is actively engaged in outreach efforts with multiple partners on the water resources impacts of climate change, focusing on public awareness, partnerships, and adaptation strategies. DWR also maintains a climate change website which provides the opportunity for the general public to e-mail climate change inquires to DWR staff.

Presentations

- DWR staff made approximately 50 presentations on climate change in 2010 (a list is provided as an appendix to this report).

Public Outreach - Displays

- DWR displayed a climate change exhibit at both the fall conference of the Association of California Water Agencies (ACWA) and the annual conference of the Colorado River Water Users Association. Materials made available to conference participants included DWR Climate Change Achievements brochures, the "Climate of Change" DWR mini documentary, winter outlooks, and posters on climate change impacts and activities.

Public Outreach - Exhibits

- DWR held initial discussions with the Aquarium of the Pacific in Long Beach, which has an average annual attendance of 1.8 million visitors, regarding installation of a DWR exhibit on climate change and water. In 2010, the space to be dedicated for the proposed two-year exhibit was identified; exhibit construction will occur in 2011, with opening scheduled for fall 2011.
- DWR met with representatives from the Fairmead Fossil Discovery Center (FDC) in Madera County in October 2010 to discuss an opportunity for DWR to produce a climate change and water-focused exhibit. The FDC displays numerous extinct species that formerly lived in the Central Valley of California. Establishing an educational display that incorporates recent climate change impacts which have been measured by DWR, provides an important opportunity to put contemporary water management challenges and climate change in the context of geologic time and help members of the public understand the reason for the high level of concern in the scientific community about the implications of rapidly changing climate.

Public meetings

- DWR held three public meetings in association with initiation of the National Research Council West Coast Sea Level Rise Study. The purpose of the meetings was to inform the public about the study's scope and to solicit data and information that might be relevant to the work.
- DWR Climate Change Team provided climate change support at 28 IRWM stakeholder meetings throughout the state. Guidance documents that were made available have been posted on the public climate change website (see Website section of this Outreach report, below).

Workshops

- DWR Co-Sponsored NOAA's annual Climate Predictions Applications Workshop with NOAA, including the National Weather Service, in March in San Diego. The primary audience for this event was NOAA staff and their partners in the academic research community.
- DWR climate staff led the 2010 Environmental Scientist Conference, held in September in Sacramento, by conducting conference coordination, technology coordination, and acting as moderators, speakers and timekeepers. Over 170 DWR Environmental Scientists and colleagues attended "Sustainability and Resilience in the Face of a Changing Climate." Twenty seven oral presentations and fourteen posters were shared, with session topics that included "promoting resilient ecosystems", "climate change and other impacts to sensitive species," and updates on regional research activities.
- The Department's Water & Climate Change Adaptation Symposium was held in October, in Long Beach, in partnership with the Water Education Foundation. This year, the Symposium highlighted linkages between freshwater and coastal impacts, and focused on adaptation planning and emerging science issues and trends. The primary audience for this event was staff and board members of local water agencies.
- The third annual Winter Outlook Workshop (WOW) was held in November in San Diego, bringing together western US climate experts to provide the first long-range outlooks for California's upcoming rain season. This event was also web-cast.

Conferences

- DWR staff organized two climate change sessions at the California Water and Environmental Modeling Forum Annual Meeting in February in Pacific Grove. Eight presentations focused on "Climate Change: Eyeing Storms of the Future," with two of the presentations by DWR staff.
- In September, DWR staff actively participated in climate change activities related to the Bay-Delta Science Conference, a biennial event that brings together hundreds of policy makers, resource managers and scientists to share the latest research and management practices related to the Sacramento-San Joaquin Delta. DWR staff organized four climate change sessions, with twenty talks focused on addressing climate change in Delta planning and management. DWR staff chaired three of the four sessions, and three talks presented by DWR staff.

Reports/Articles

- Beginning in April, the climate change staff began compiling and distributing relevant climate change articles, reports and other current resources into two publication formats:
    - The Climate News is a list of recently published resources directly or peripherally related to climate change and water management in California, and is publicly accessible at http://www.water.ca.gov/climatechange/news.cfm.
    - The Climate News Digest is a broader compilation of articles, reports, blogs, legislative updates, and other resources related to climate change that is intended to keep DWR staff members up to speed on a variety of current climate change-related issues. Current and archived Climate News

Digests are available to DWR staff members at http://dwrclimatechange.water.ca.gov/digest.html.

These products are both created approximately every three weeks.

- Bay-Delta Office staff published "Isolated and integrated effects of sea level rise, seasonal runoff shifts, and annual runoff volume on California's largest water supply," in the *Journal of Hydrology*, by Drs. Jianzhong Wang, Hongbing Yin and Francis Chung, June 12, 2011 (available at: http://dx.doi.org/10.1016/j.jhydrol.2011.05.012).
- "DWR Climate Change Achievements" brochure was released in September, highlighting statewide and regional approaches to climate change adaptation and mitigation in the water sector. The brochure is a high-gloss color 12-page document that can be accessed electronically at: http://www.water.ca.gov/climatechange/docs/CC-Achievements-9_28_10.pdf
- Support materials were compiled and posted on the web for use by Integrated Regional Water Management groups, including new resources and key documents (IRWM Climate Change Document Clearinghouse) and a vulnerabilities chart (Climate Change Vulnerability Matrix), available at: http://www.water.ca.gov/climatechange/resources.cfm

Website

- In early 2010, DWR completed a complete redesign and update of its public climate change site (www.water.ca.gov/climatechange). The improved website adds several new features including updated publications; a new featured link highlighting one new item on the site, "Climate News" described above. Since the launch of the website new publications, news articles, and other resources have been added regularly.
- In mid-2010, DWR launched an internal climate change webpage to host documents and resources for DWR staff. The internal website is only available on DWR networked computers and allows the DWR Climate Change Program to share non-public information with all other DWR employees, improving coordination, cooperation, and general knowledge of the activities that are going on throughout DWR. It contains all of DWR's guidance on addressing climate change in California Environmental Quality Act (CEQA) documents, an archive of past project documents that have addressed unique climate change issues, and a log of all CEQA documents that have been reviewed by the DWR CEQA Climate Change Committee. Also available on the site is information about the DWR Climate Change Matrix team, an archive of presentations and other outreach materials for use by DWR staff, the "*Climate Change Digest*" featuring news articles and other publications related to water and climate change (meant for internal use), and a "Climate Change Coordination" page featuring links to various studies and activities being conducted by DWR staff.

Outreach - Internal

- In August, approximately 20 DWR staff attended internal cross-training seminars on Climate Change and the Delta. California's weather, climate, climate change, methods to assess impacts, and adaptation strategies were presented, followed by a seminar on the Sacramento-San Joaquin Delta from a water resources management perspective. Designed as a template and testbed for a broader Climate Change Literacy class to be held in 2011, steps were taken in 2010 to develop the course with the DWR Training Office.

International Collaboration

- Jessica Rossell, Senior Policy Officer, Impacts & Adaptation Section, New South Wales (Australia) Department of the Environment, Climate Change and Water, spent three weeks at the CA Dept. of Water Resources in October, 2010. In addition to attending meetings and briefings on climate change policy, she presented to the Climate Change Matrix Team, attended the 2010 Water & Climate Change Adaptation Symposium and built professional alliances throughout the state's water community. She familiarized DWR with NSW initiatives and projects which inform our own climate change efforts, and may provide opportunities for future collaboration. The NSW Department of Environment, Climate Change and Water is responsible for developing and coordinating programs to address the impact of climate change in NSW, as well as the administration of numerous other environmental protection programs. For more information see www.environment.nsw.gov.au.

State Climatologist's Office
Status: **Ongoing**
Contact: **Dr. Michael Anderson**

The California Office of the State Climatologist (OSC) is housed in the California Department of Water Resources (DWR) Division of Flood Management. Interacting with other divisions within DWR which composes the state climate office (SCO) and the California Climate Data Archive (CalClim) at the Western Regional Climate Center (WRCC), the OSC provides a growing range of climate services for California.

Work continued on many fronts over the past year. NOAA is working to produce an update to its rainfall frequency product for California which should be released sometime in spring 2011. California's Bulletin 195, a compilation of depth-duration-frequency curves, continues to be updated with the help of retired State Climatologist, Jim Goodridge. Efforts are underway to bring the Jim's computational methods into an automated structure within DWR and examine ways to address climate change in Bulletin 195. Both of these products will be used in an effort to produce hydrologic information for floodplain mapping and other hydrologic and hydraulic studies associated with California's FloodSAFE program.

Collaboration with NOAA and Scripps Institution of Oceanography continues on the development of an extreme precipitation monitoring network that will include stations to monitor atmospheric water vapor, soil moisture sensors, and vertically pointing radar to detect freezing level in the atmosphere. The project, born out of NOAA's Hydrometeorological Testbed work in the American River watershed, is a five-year effort to outline the initial components of a statewide monitoring network to improve precipitation forecasts and increase lead time for flood mitigation actions. Four snow-level-radar installations have been completed and are reporting data to the California Nevada River Forecast Center. On the soil moisture monitoring front, a workshop was held in May 2010 at which several agencies and researchers shared their work in soil moisture monitoring and discussions were held on how to patch together a potential statewide network. Since the workshop interest has grown in soil moisture monitoring and more sites are likely to be installed. A follow up to the workshop will be held later in 2011. Another development this past year for this collaboration is the expansion of the effort to include four partial atmospheric river observatories along the coast of California. This effort will expand the investment in the network from $7.5 million to $10.5 million. The final configuration of the initial investment of the network is shown in Figure 1.

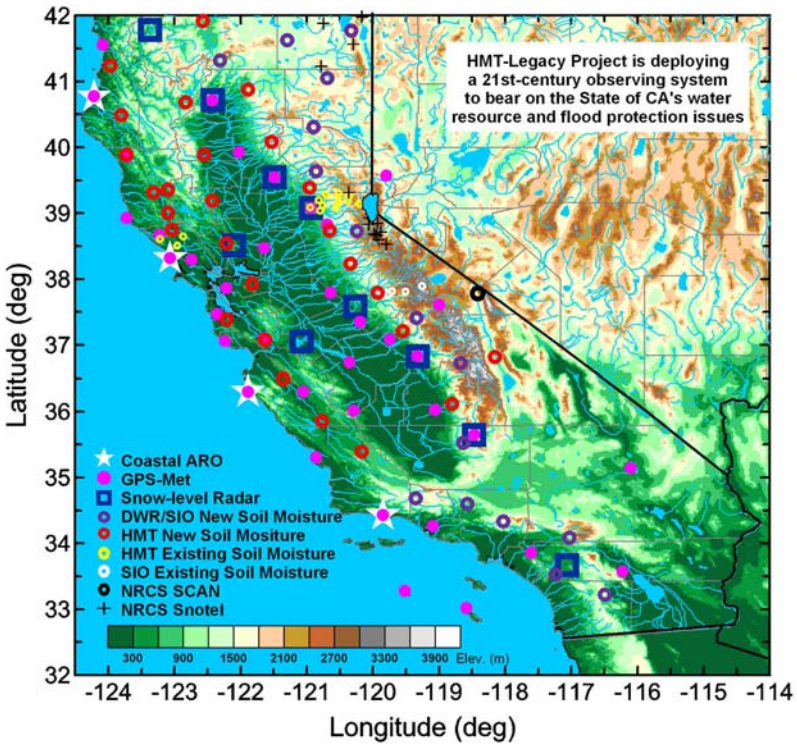

Figure 1. Final buildout plan for 21st Century Observing Network project with NOAA ESRL and Scripps.

The California State Climatologist is also partnering with NOAA for a National Interagency Drought Information System (NIDIS) pilot project in California. This effort will include participation from several federal agencies, DWR, the California-Nevada Applications RISA and Western Region Climate Center. Two organizational meetings have been held so far. A strategy for implementing the pilot effort is expected by summer of 2011.

California is now in year three of the Community Collaborative Rain, Hail & Snow Network (CoCoRaHS). Over 780 volunteers have signed up with NWS Weather Forecast Offices taking the lead as regional coordinators with help from some DWR personnel. Observers are located in 52 of California's 58 counties. Approximately 9000 reports are submitted per month from California's CoCoRaHS volunteers. A summary of activity is provided in the State Climatologist monthly summaries.

Data serving for California climate data improved this past year with the help of a collaborative project between DWR and Western Region Climate Center. The effort looks to identify quality control routines and tools to examine data from the California Data Exchange Center. Histogram and wind rose graphics are some examples of these new tools, which are housed in the California Climate Data Archive. A final report for the project was submitted in March of 2011. Further collaborations are being explored. Data serving continues via the web, phone and email. A new interface for spatial depictions of data in the California Data Exchange Center is expected to be released in summer of 2011.

Travel and presentations were prominent again this past year. Presentations and/or session moderating duties included meetings for the California Water and Environment Modeling Forum, California Cooperative Snow Surveys Annual Meeting, invited talks at different locations within California including the Long Beach Aquarium.

Out-of-state travel was limited this past year due to budget problems and will continue to be a challenge in the coming year.

California, with help from the Nevada State Climate Office, hosted the 2010 annual meeting of the American Association of State Climatologists. The meeting was held in South Lake Tahoe from July 12-15. The meeting was a large success with over 30 SC's in attendance. At the meeting the California State Climatologist was presented a meritorious service award from DWR leadership and was also voted to become the AASC treasurer from 2011-13.

The annual "WERA-102" Committee meeting, composed of western State Climatologists, the Western Region Climate Center, and federal resource agency partners, was hosted by the OSC and the Monterey Weather Forecast Office for the second year. Three new members attended and good discussions were held on data collection, state of the National Climate Service, and climate change work being carried out in different states.

The State Climatologist has also been involved in the Department's Climate Change Matrix Team and FloodSafe's Central Valley Hydrology Study and Central Valley Flood Protection Plan. The matrix team meets quarterly to discuss all things climate change related to the Department. The Central Valley Hydrology Study is developing new design hydrology data to help the Department's floodplain mapping and flood project studies activities. This effort will include a climate change component in which the State Climatologist will be taking a lead role. The Central Valley Flood Protection Plan (CVFPP) is a five-year plan that presents the flood protection project activities that need to be implemented for the Central Valley. A climate change working group developed a threshold method to account for climate change in flood management planning. The document is available on the CVFPP website.

Nine task orders have been approved for the climate services contract with the University of California system. Activity ranges from water year outlook workshops to modeling studies for flood management to field monitoring installation programs. The contract greatly expands the capabilities of project execution for the State Climate Office.

Looking ahead to the coming year, the California OSC plans to continue coordination of activities with the CalClim Group and the WRCC, and continue development of the website and its capabilities to improve data serving. The State Climatologist will also continue efforts to engage climate researchers active in the State and continue collaborative efforts with NOAA personnel and others.

Presentations and Posters

Jamie Anderson
Downscaling and Climate Change Modeling, Environmental Scientists' Workshop, September, Sacramento.

Dr. Michael Anderson
"Future Storms for Hydrologic Planning," CWEMF, February, Pacific Grove.
Three talks on climate change hydrology, NOAA Workshop, March, San Diego.
"Climate Change and Scale Issues," March, Sonoma County.
"Water Supply, Flood Management, and Climate Change," California Water Law and Policy, April, San Francisco.
California Climate Change Program Activity, AASC Annual Meeting, July, Lake Tahoe.
"California Climate Past, Present, and Future," Environmental Scientists' Workshop, September, Sacramento.
"Climate Change Hydrology," Bay Delta Science Workshop, September, Sacramento.
Lecture on California Climate, DWR Climate Change Workshop, October, Long Beach.
"Water Year Review and Outlook," CCSS Annual Meeting, October. Bishop.
Climate Change Hydrology, WERA-102 Committee Meeting, November, Monterey.

John Andrew
"Envirobro" Radio Program, January, Sacramento.
National Climate Assessment, February, Chicago.
Climate Prediction Applications Science Workshop, March, San Diego.
Carpe Diem Western Water and Climate Change Project, March, San Francisco.
California-Nevada Section of American Water Works Association, April, Hollywood.
Green California Conference, April, Sacramento.
Law 285T, UC Davis King School of Law, April, Davis.
Sustainable Water Resources Roundtable, April, Palo Alto.
US Environmental Protection Agency Climate Change Conference, June, San Francisco.
California Council for Environmental and Economic Balance, June, Squaw Valley.
Law 285T, UC Davis King School of Law, September, Davis.
Environmental Scientists' Workshop, September, Sacramento.
US State Department International Visitor Program, September, Sacramento.
National Hydropower Association, October, Sacramento.
Dutch Young Professionals Delegation, October, Sacramento.

Baroyhay Davidoff
Water-Energy Nexus Workshop, March, Oakland.

Jeanine Jones
Applied science needs for adaptation at NOAA/NWS/DWR Climate Predictions Applications Workshop, March 2010, San Diego.
Water & Climate Variability/Change/Adaptation, September, Long Beach.
DWR's Climate Change Symposium, October, Long Beach.
Western States Water Council presentation on California adaptation plans, October, San Diego.

Lauma Jurkevics

Presentation on *DWR's Climate Action Plan and CEQA Guidance* at Climate Change & Sustainability Environmental Scientist Workshop, September, Sacramento.

Poster Presentations: *Climate Change at the Department of Water Resources* and *Climate Change: Stressing Our Water Systems*, Proposition 84 IRWM Grant Program Round 1: Planning Grant Workshop, September, Riverside.

DWR Climate Change Achievements Poster Display, Water & Climate Change Adaptation Symposium: From the Sierra to the Ocean, October, Long Beach.

DWR Climate Change Achievements Poster Display, DWR Winter Outlook Workshop, November, San Diego.

ACWA Conference, Poster Presentations: *Climate Change at the Department of Water Resources* and *Climate Change: Stressing Our Water Systems*), November-December, Indian Wells.

Tariq Kadir

"Potential Impacts of Climate Change on the Upper Feather River Basin Hydrology," Environmental Scientists' Workshop, September, Sacramento.

Abdul Khan

"Climate Change Characterization in California Water Resources Planning Studies," Bay-Delta Science Conference, September, Sacramento.

Elissa Lynn

"Water Management in a Changing Climate," League of Women Voters, October, Woodland.

Environmental Scientist Workshop outreach presentation, September, Sacramento.

Climate Change Achievements Poster and "Climate of Change" video, Bay-Delta Science Conference, September, Sacramento.

Katy Spanos

Environmental Scientists' Workshop, "Current Legal Issues," September, Sacramento.

Association of California Water Agencies, "Climate Change and Local Water Agencies," December, Indian Wells.

Maury Roos

"Climate Change, Sea Level Rise and the Delta," Water Education Foundation Tour, July, Headlands Institute, Sausalito.

"Can We Save the California Delta?," International Commission on Irrigation and Drainage Conference, October, Yogyakarta, Java Island, Indonesia.

Andrew Schwarz

DWR NEPA/CEQA Training Class, February, Sacramento.

Jianzhong (Jay) Wang, Hongbin Yin, and Francis Chung

"Climate Change Impact on Water Resources," California Water and Environmental Modeling Forum, February, Pacific Grove.

Climate Change Matrix Team

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